

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re patent application of:	)	
	)	
FAN, XUE-JUN, <i>et al.</i>	)	
	)	Examiner: SMITH, C. L.
Serial No.: 10/562,528	)	
	)	Group Art Unit: 2835
Filed: DECEMBER 28, 2005	)	
	)	
For: LIGHT-EMITTING DIODE	)	
THERMAL MANAGEMENT	)	
SYSTEM	)	

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**DECLARATION OF XUE-JUN FAN UNDER 37 C.F.R. 1.131**

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Dear Sir:

I acknowledge that willful false statements and the like are punishable by fine or imprisonment or both (18 U.S.C. 1001) and may jeopardize the validity of the application or any patent issuing thereon. All statements contained herein made of my own knowledge are true and all statements made on information and belief are believed to be true.

1. I, XUE-JUN FAN, am a former employee of Koninklijke Philips Electronics N.V. where I worked and performed research relating to the above named application since prior to January 17, 2003.

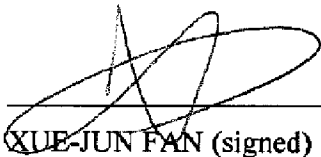
2. I am an inventor named in the United States Patent Application Serial No. 10/562,528, filed December 28, 2005, which is the National Stage Entry of PCT No. PCT/IB04/02055 filed June 21, 2004, and which claims priority to United States Provisional Patent Application No. 60/483,768, filed June 30, 2003.

March 31, 2008  
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Filed: December 28, 2005  
Page 2

3. The attached Exhibit A is a copy of documents illustrating a date of conception of the present invention prior to at least January 17, 2003.

4. Prior to the filing date of the provisional patent application, I worked diligently with patent attorneys to prepare for the filing of a provisional patent application that was filed with the USPTO on June 30, 2003, and subsequently assigned Application Serial No. 60/483,768. A search was requested on March 20, 2003, and completed on April 29, 2003.

5. The above paragraphs illustrate prior conception and reasonable due diligence during at least the time between January 17, 2003, and the June 30, 2003, filing date of Application Serial No. 60/483,768.

  
XUE-JUN FAN (signed)

03/31/2008

Date

Xuejun Fan  
XUE-JUN FAN (print)

# INVENTION DISCLOSURE

703911

KRAU

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ID ABSTRACT TO: Betsy McIlvaine	FOR IP&S USE ONLY	
FOR ADMIN USE ONLY		
ECCN: NLR EAR99	ECO Initials: BM	ECCN Date: 17 Jan 03
LRTO: PWE		

## INSTRUCTIONS:

1. Description should be supplemented by attaching copies of relevant documents, such as published articles or patents, product brochures, engineering notebook pages and drawings.
2. All inventors must sign the Disclosure of Invention.
3. Please submit completed form to Export Control Officer (ECO), who will assign an ECCN and forward this disclosure to IP&S. Please print single-sided, and do not send duplicates or send directly to IP&S.

03 JAN 17 AM 9:07

**Recommendation:** Management / patent coordinator as to urgency, commercial importance, and competitors' activities:

☐ LOW

☐ MED

☐ HIGH

<b>Title of the invention:</b>			
Applications of Flex Circuit Tape and Thermal Via in LED Thermal Management			
Name(s) of the inventors	Division Location /ISC Manager's Name	Email/Tel./Job Title	Home Address
Xuejun Fan	BQR/Gert Bruning	Xuejun.fan@philips.com (914)-945-6338 Title: SMRS	Citizenship: P.R. China
Peng Xu	BRQ/Gert Bruning	Peng.xu@philips.com (914)-945-6312 Title: SMRS	Citizenship: P.R. China
		@ ( ) Title:	Citizenship:
		@ ( ) Title:	Citizenship:
<b>PRIMARY CONTACT</b>			
Who should IP&S contact for further technical information about the invention and its planned use or public disclosure?			
Inventor Name: Xuejun Fan or Peng Xu			

EXHIBIT A

## INVENTION DISCLOSURE (continued)

**Summary of the invention, where KEY WORDS are underlined which might be useful in searching for relevant patents or publications:**

The applications of flex circuit tape and the thermal via in lighting emitting diode (LED) thermal management and assembly can reduce the thermal resistance and therefore improve LED performance.

**Detailed description of the invention on annexes; please describe preferred embodiments and their advantages over prior solutions in detail; please include drawings. (See last 2 pages)**

### STAGE AND IMPORTANCE OF THE INVENTION:

- a. Stage of the invention? ☒ Idea ☐ Pre-development ☐ (trial) manufacture  
☐ Research ☐ Development
- b. Was the invention made under a government contract? ☒ No ☐ Yes, contract number: \_\_\_\_\_
- c. Date of Conception of Invention: 01/10/2003
- d. Date of First sketch, drawing (provide copy if available): 01/15/2003
- e. Date of first written description (provide copy): 01/16/2003
- f. Date of completion of first model or full sized device: N/A
- g. Date of first successful test: N/A
- h. In what products, processes or systems could the invention be used? LED related lighting system
- i. For which other business units of Philips could the invention have relevance? \_\_\_\_\_
- j. For which competitors of Philips could the invention have relevance? Why? \_\_\_\_\_

### DISTRIBUTION OF INFORMATION CONCERNING THE INVENTION

When, how, where and to whom will information concerning the invention be distributed outside Philips?

*Please consider publications, hearings, exhibitions, offers, contacts with potential customers or suppliers, issuing of samples, trade shows, test sites, public demonstrations, public displays and first offers for sale or commercial use, experimental use outside Philips such as research partnerships, beta tests, regulatory requirements.*

Has a description of the invention been, or will be, published or submitted for publication? ☒ No ☐ Yes  
 If Yes, provide dates and names of publications: \_\_\_\_\_

**N.B. Even after sending this Invention Disclosure to Philips Intellectual Property & Standards, any such acts will impair patentability of the invention. Please contact Philips Intellectual Property & Standards before information concerning the invention leaves Philips.**

### SUPPLEMENTAL INFORMATION CONCERNING THE INVENTION

- a. Is the invention the result of cooperation with persons outside Philips? ☒ No ☐ Yes  
 If so, with whom? \_\_\_\_\_
- b. Is there, or will there be, an internal report on the invention? ☒ No ☐ Yes  
 If so, please state the number. \_\_\_\_\_
- c. Are there, or will there be, other invention disclosures relating to this invention? ☒ No ☐ Yes  
 If so, please state Ref. no. \_\_\_\_\_
- d. Are there other persons who could give information on the invention? ☐ No ☒ Yes  
 If so, who? Gert Bruning (BQR/Dept Head)

## INVENTION DISCLOSURE (continued)

In your detailed description, please indicate:

### PRESENT STATE OF THE ART

*Briefly describe the closest already-known technology that relates to the invention. This would include, for example, already existing products, methods or compositions which are known to you personally or through descriptions in publications.*

US 6,428,189 B1 (issued on 08/06/2002) disclosed a method to reduce the thermal resistance of LEDs assembly. The assembly is characterised by the circuit board presenting a hole therethrough and surrounding each of a plurality of LEDs (e.g. see Fig. 1). In other words, Each LED extends through the hole in the circuit board with the light emitting portion or lens extending from one of the surfaces of the circuit board and the heat sink extending from the other one of the surfaces of the circuit boards.

### PROBLEM SOLVED BY THE INVENTION

*Briefly describe the problem for which the invention provides a solution. Is this problem new?*

The prior art provides an idea to present holes on the circuit board to allow the direct attachment of each LED to the heat spreader. Without holes, if the LED are attached to the circuit board and circuit board is attached to the heat spreader, significant thermal resistance might occur (see Fig. 2).

### ADVANCEMENT IN STATE OF THE ART

*Briefly describe the unique advancement achieved by the invention. This may be done, for example, by describing a problem with the prior art that is solved or specific objects that are achieved by the invention.*

This invention includes following embodiments.

1. The flexible tape (flex) circuit can be introduced, with which, the holes through the flex are really not necessary since the flex thickness is very small and does not contribute too much thermal resistance (see Fig. 3);
2. Thermal via can be made and embedded on the circuit board, beneath and around each LED. With the introduction of thermal via, the direct heat dissipation path from LED devices and heat spreader is formed. Therefore the thermal resistance is reduced (see Fig.4);
3. Thermal via can be combined with flex circuit board, or used in regular circuit board (see Fig.5);
4. In many applications, multi-layer board is required. The thermal via can be used and has advantage in multi-layer board applications (see Fig. 6)
5. Since the prior art is limited to one-lays, board only, the holes can be extended to multi-layer applications (see Fig.7).

### WHAT IS THE BEST WAY YOU KNOW OF TO IMPLEMENT THE INVENTION?

*Briefly describe the invention and how it achieves the advancement described above. Please include at least one embodiment of the invention, with drawings, graphs, test data etc.*

*(Please Note: If we decide to file an application on this invention, the attorney writing the application will need this information from you in as much detail as possible in order to complete the application.)*

This invention provides the following methods to achieve the advancements.

1. The flex circuit is laminated to the heat sink or heat spreader, then LED mounted to the circuit board (Fig.8);
2. The regular circuit board with thermal via is attached to heat sink first then LEDs are mounted (Fig. 9);
3. The LEDs are mounted to the circuit board with thermal via and then whole assembly attached to the heat spreader (Fig. 10);

## INVENTION DISCLOSURE (continued)

### SIGNATURES

*Disclosures must be signed by all of the inventors.*

INVENTOR #1: \_\_\_\_\_ Date: \_\_\_\_\_

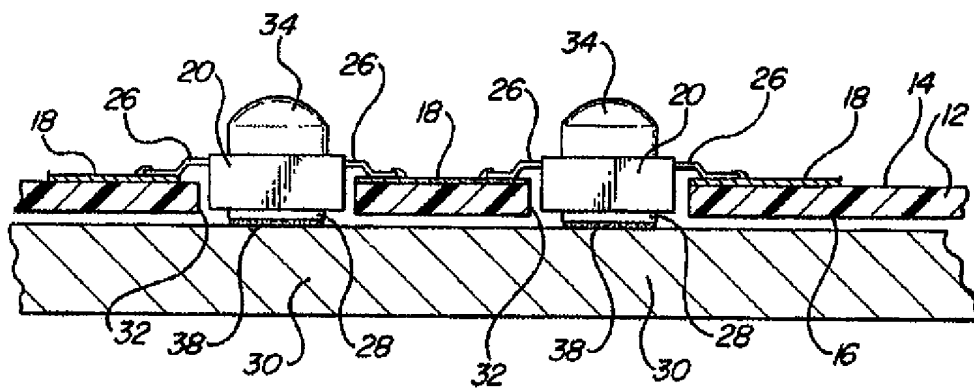
INVENTOR #2: \_\_\_\_\_ Date: \_\_\_\_\_

INVENTOR #3: \_\_\_\_\_ Date: \_\_\_\_\_

INVENTOR #4: \_\_\_\_\_ Date: \_\_\_\_\_

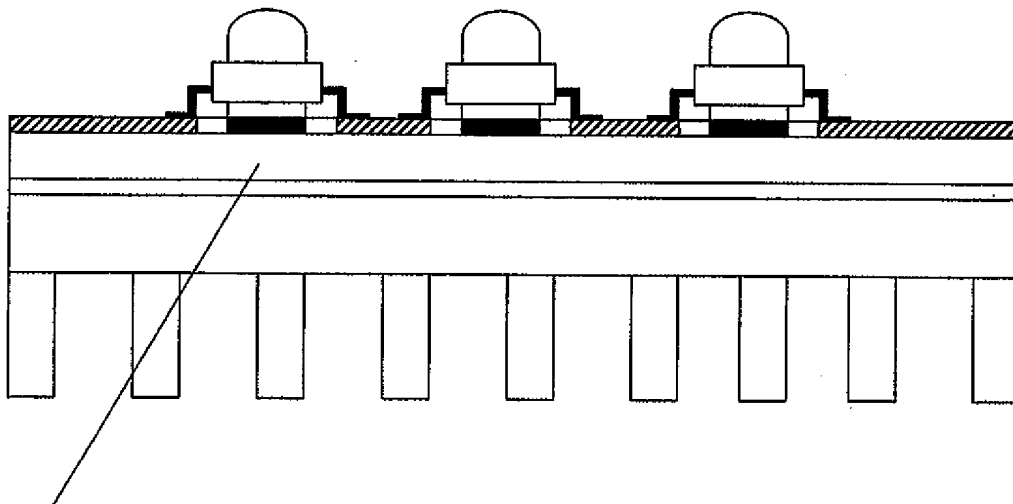
## INVENTION DISCLOSURE (continued)

**Fig. 1 Prior art (32: hole)**



## INVENTION DISCLOSURE (continued)

Fig. 2 Problem to be solved in this invention

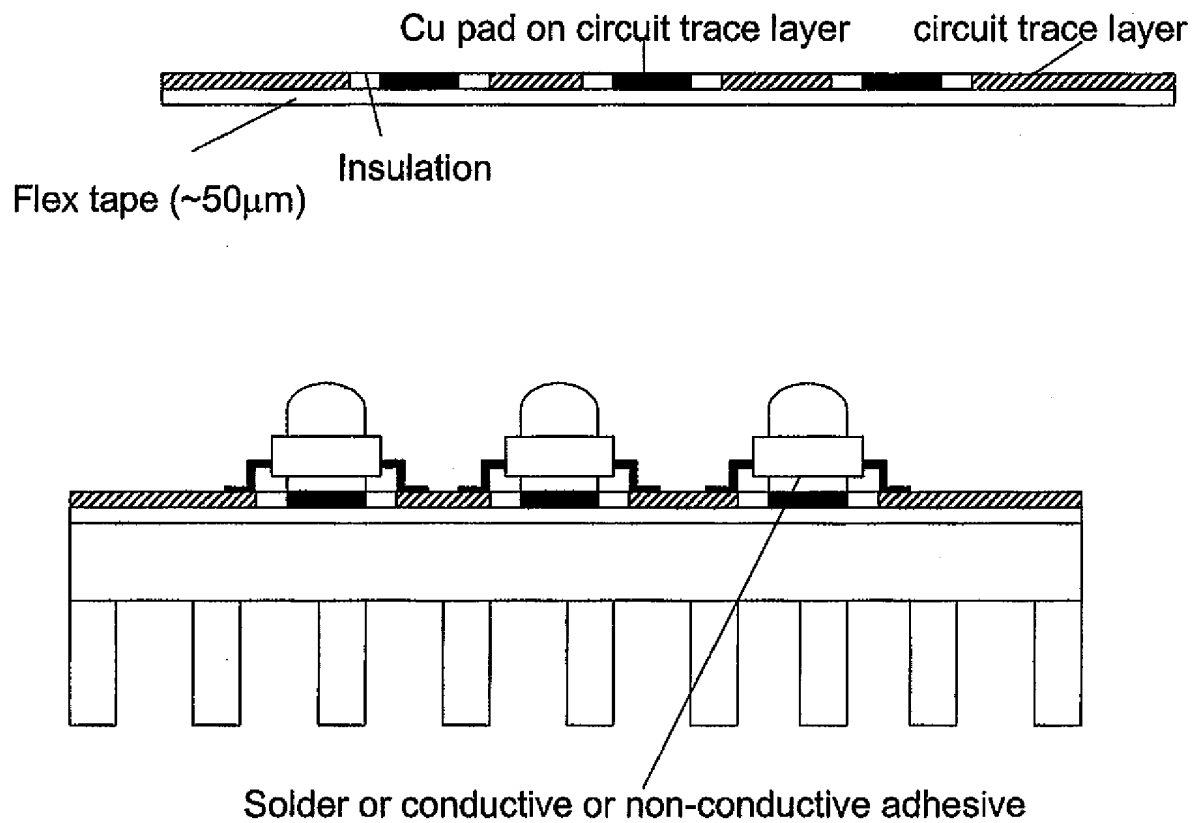


Significant thermal resistance might be caused if the holes are not present on the circuit board



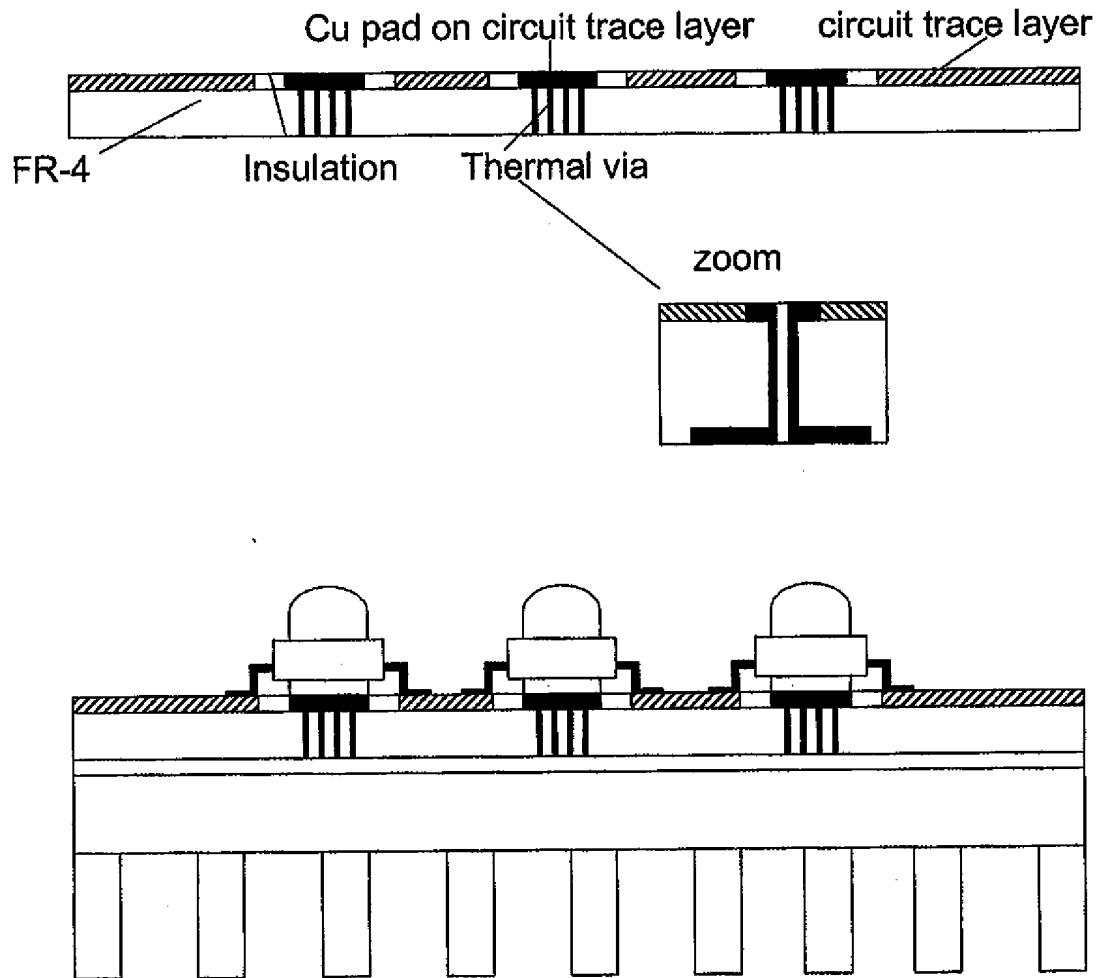
## INVENTION DISCLOSURE (continued)

Fig. 3 Flex circuit tape application



## INVENTION DISCLOSURE (continued)

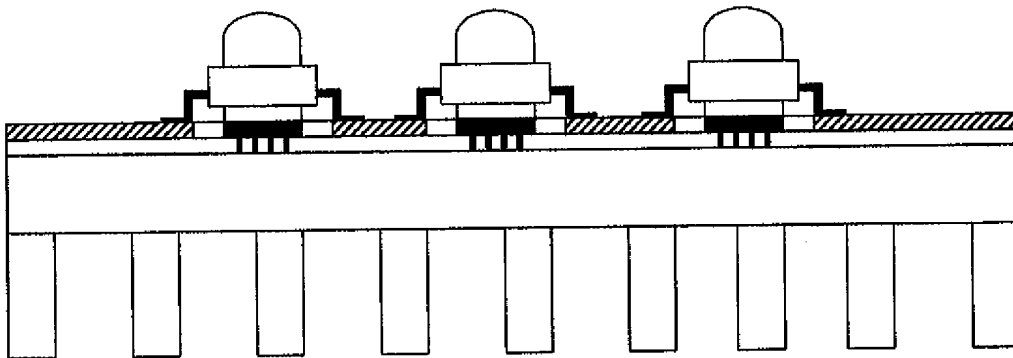
Fig. 4: Thermal via application



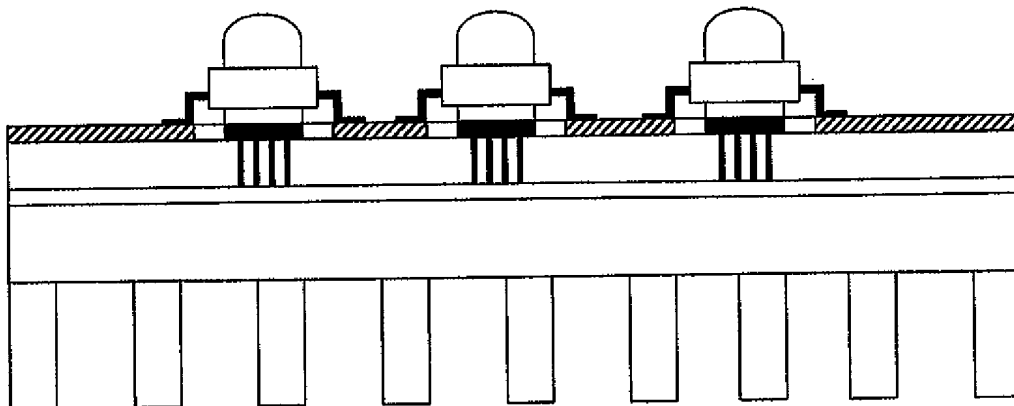
## INVENTION DISCLOSURE (continued)

Fig.5 : Thermal via applications with flex and regular circuit boards

Flex substrate

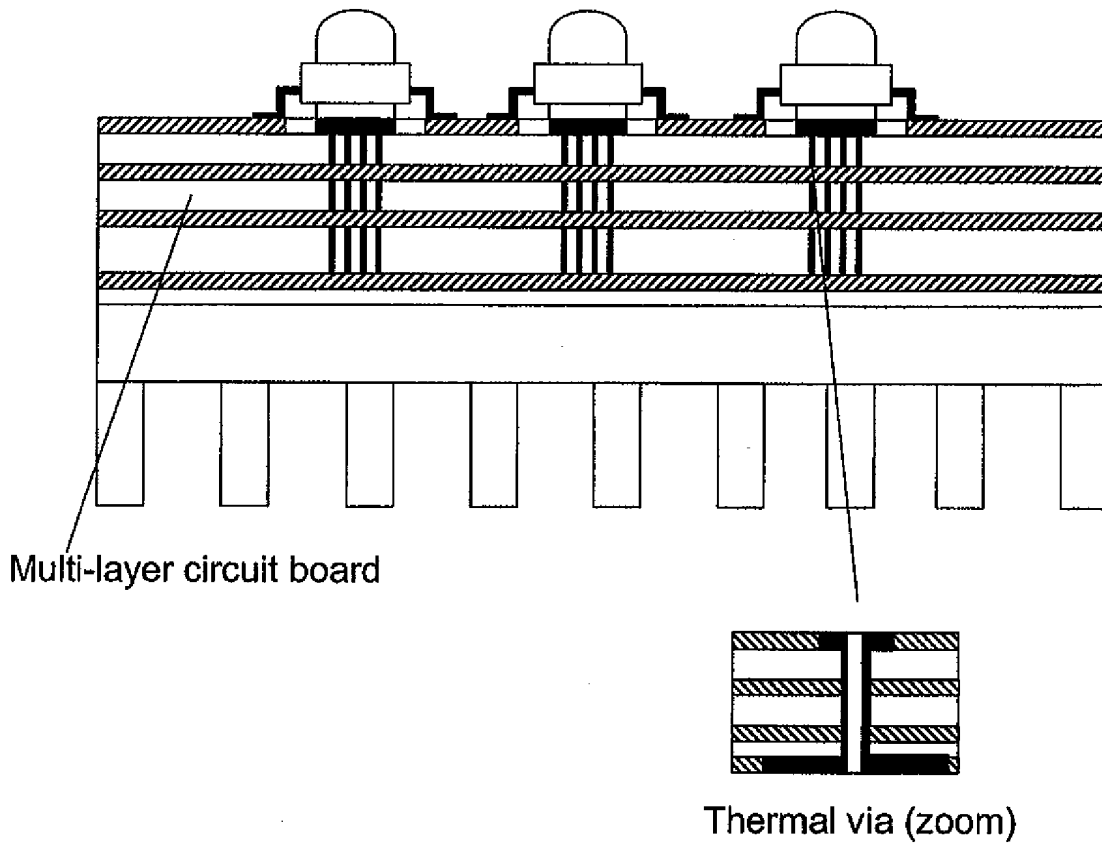


Regular circuit board substrate



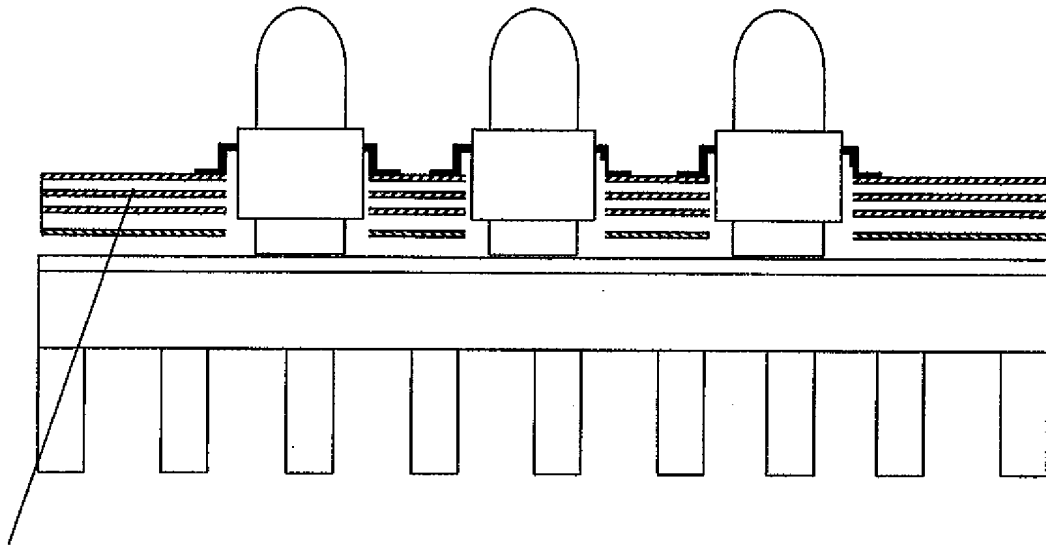
## INVENTION DISCLOSURE (continued)

Fig. 6 Multi-layer circuit board application



## INVENTION DISCLOSURE (continued)

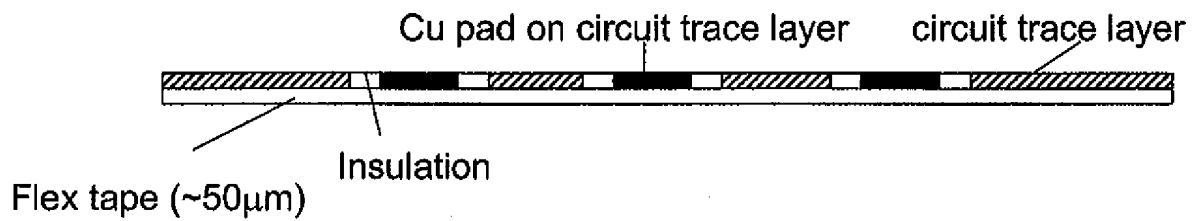
Fig. 7 Multi-layer circuit board application wit hole



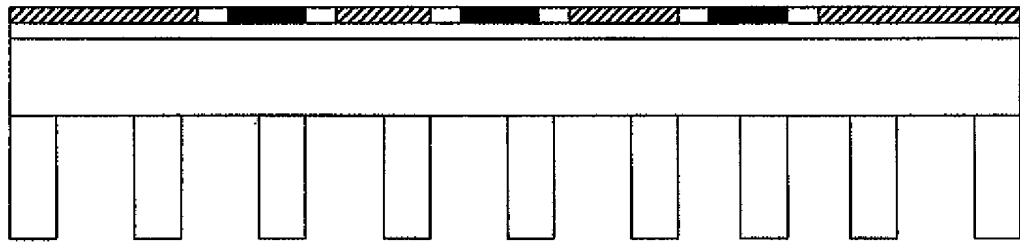
Multi-layer circuit board

## INVENTION DISCLOSURE (continued)

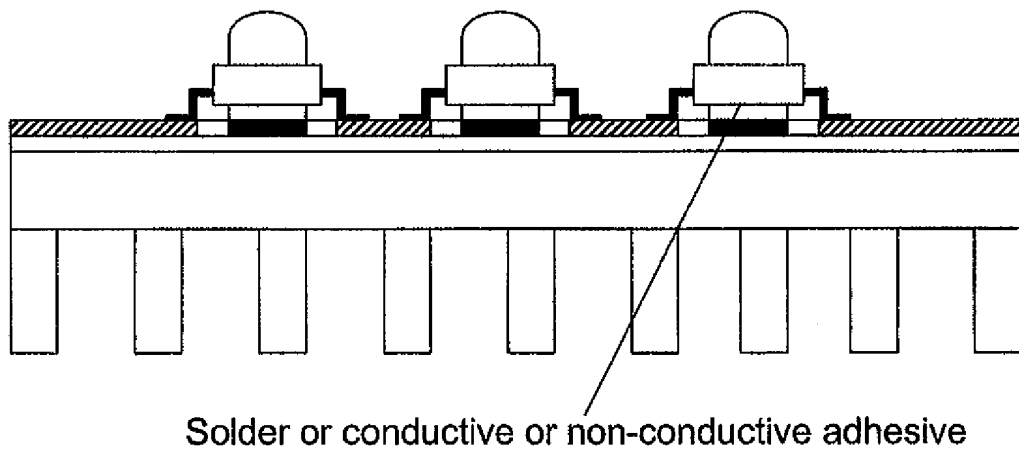
Fig. 8 Process step for flex circuit tape application



Flex tape laminated to heat sink or heat spreader

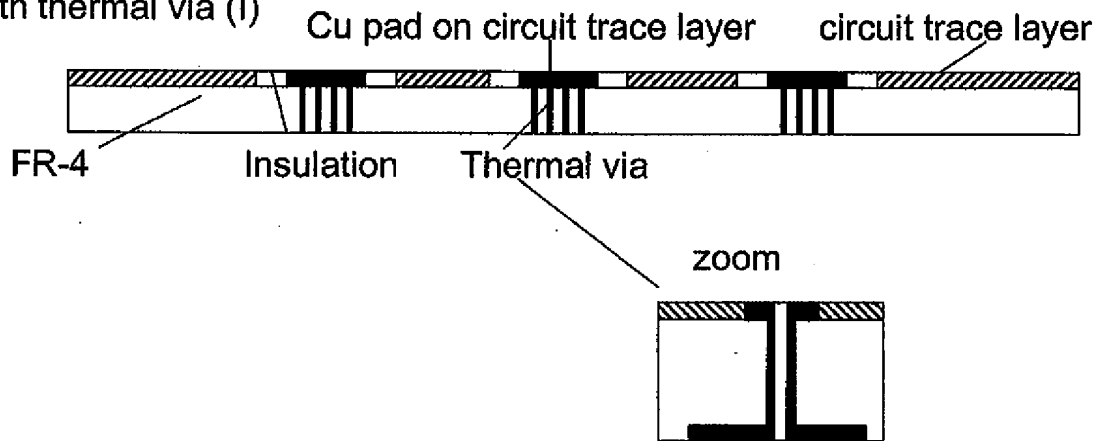


LEDs mounted to the circuit board

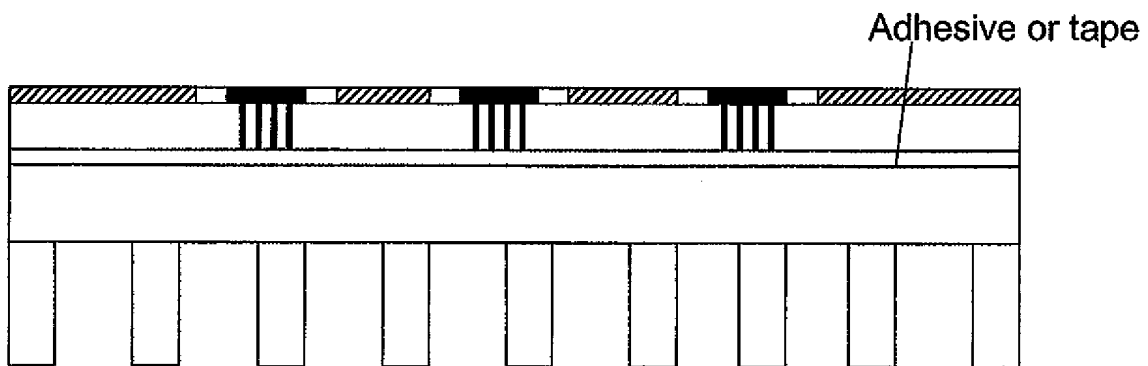


## INVENTION DISCLOSURE (continued)

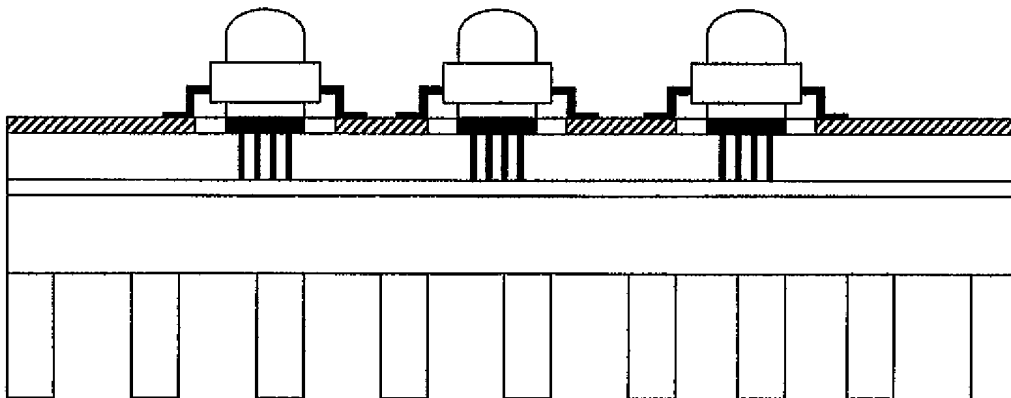
Fig. 9 Process step for regular circuit board (e.g. FR-4 based) with thermal via (I)



The circuit board attached to heat sink or heat spreader

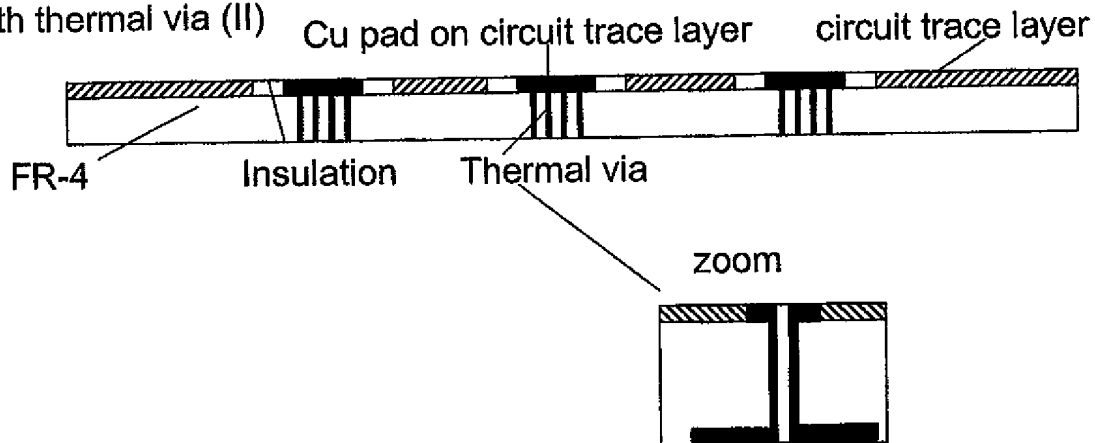


LED assembly attached to heat sink or heat spreader

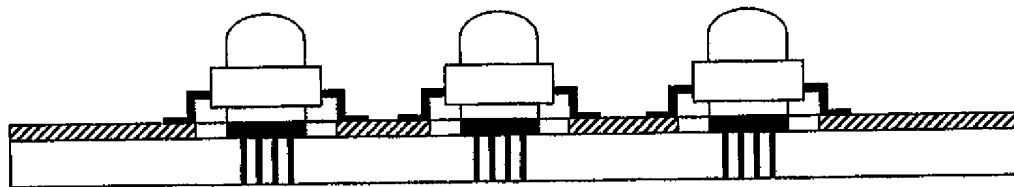


## INVENTION DISCLOSURE (continued)

Fig. 10 process step for regular circuit board (e.g. FR-4 based)  
with thermal via (II)



LEDs mounted to the circuit board



LED assembly attached to heat sink or heat spreader

